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(54) SEMICONDUCTOR DEVICES

(71) We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED of Abacus House, 33, Gutter Lane, London, E.C.2., a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a semiconductor device comprising an insulating foil on which a pattern of conductor tracks is present, a semiconductor body having contact places which are connected to facing ends of the conductor tracks, external conductors which are connected to the other ends of the conductor tracks, and an envelope for the semiconductor body, the foil and a part of the conductors.

In manufacturing such a semiconductor device provided with an envelope of a synthetic resin, it is known to connect the conductor tracks of the foil to leads incorporated in a lead frame, which leads extend to near the semiconductor body. Such a lead frame is rather complicated and hence comparatively expensive. Furthermore, in the case of a foil having a different pattern of conductor tracks, an adapted lead frame must be used. Furthermore, in the known semiconductor device no measures are taken to obtain efficient cooling of the semiconductor body so that only low power operation is obtained.

In another known semiconductor device having a foil incorporated in a synthetic resin and having conductor tracks to which a semiconductor body is secured, the external conductors are also provided on the foil and that as thickened parts. The manufacture of the foil with the conductor tracks and external conductors is complicated, and no measures are taken to obtain efficient cooling.

According to the present invention there is provided a semiconductor device comprising an insulating foil on which a pattern of conductor tracks is present, a semiconductor body having contact places which are connected to facing ends of the conductor tracks, external conductors which are connected to the other ends of the conductor tracks, and an envelope for the semiconductor body, the foil and a part of the conductors, the conductors consisting of flat strips which project from the envelope on oppositely-located envelope sides, each of the conductors comprising at its end facing the foil a holding element for the foil, the distance apart of holding elements of oppositely-located conductors being smaller than the foil width at that area, and the face of the semiconductor body remote from the contact places being in thermal contact with a cooling plate which is present adjacent a wall of the envelope.

Such a semiconductor device structure permits the device to be manufactured more simply than the known semiconductor devices mentioned hereinbefore while permitting efficient cooling of the semiconductor body.

Comb-shaped strips are preferably used as conductors in the manufacture, the foil being secured to two or more equal combs which face each other with the holding elements. The manufacture of these combs is simple. For semiconductor devices having different numbers of external conductors, a number of adapted combs need not be manufactured; instead, by uniformly spacing the conductor tracks at the edge of the foil this device structure permits a greater or smaller length of a comb-shaped strip to be used to provide a greater or smaller number of conductors as required. The holding elements enable a simple connection of the foil to the conductors. The use of two or more combs furthermore creates the possibility of bringing the holding elements to a desirable spacing from each other, the foil being not tautly stretched but sagging to a desirable extent. The

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semiconductor body secured to the foil can now be pressed against a cooling plate with its side remote from the contact places without any possibility of damage. As a result of the sagging foil, the cooling plate need not be present in the plane of the conductors, but may be provided on the outside of the envelope, which is considerably more favourable for the heat dissipation.

The holding elements may consist of beak-like parts provided in the ends of the strips. Such holding elements can be provided in the conductors in a simple manner.

The face of the semiconductor body remote from the contact places may be rigidly secured to the cooling plate. This connection may consist, for example, of a soldered joint or of a joint by means of a heat-conducting glue.

The envelope may consist of a synthetic resin, and the cooling plate may have a flat exterior face which lies flush with an outer surface of the envelope. In this case the manufacture of the envelope is little complicated, while the cooling capacity is optimum.

In another form the envelope consists of a box-like housing, the cooling plate being incorporated in one wall of the housing, and the oppositely located wall comprising an inwardly-extending projection which presses the semiconductor body against the cooling plate. The box-like housing which consists, for example, of a synthetic resin, may be constructed from two parts, the conductors being secured in the interface during sealing. The semiconductor device may be manufactured with simple tools. Variation of the box shape while maintaining the same comb can be realized without great investments. If desirable, the space within the housing may be filled, for example with a synthetic resin.

Embodiments of the invention will be described, by way of example, with reference to the accompanying drawings, in which:—

Fig. 1 is a perspective view of one semiconductor device in accordance with the invention,

Fig. 2 is a perspective view of another semiconductor device in accordance with the invention.

In the semiconductor device shown in Fig. 1, a foil 1, for example a polyimide foil, has a pattern of metal conductor tracks 2 on its underside. A semiconductor body 3 comprising an integrated circuit has contact places 4. Said contact places are connected to ends of the conductor tracks facing the semiconductor body, for example, by means of a soldered joint. A row of external conductors 5 which, during the manufacture of the semiconductor device, are connected by a supporting strip 6 and each constitute a so-called conductor comb, are present on two oppositely located sides of the semiconductor device. Said combs may consist of a metal having a low electric resistance; the mutual spacing of the conductors may be standardized, and is usually 2.54 mm. Of such a comb-like strip a length is taken which has the desired number of conductors. The same comb-like strip may thus be used for semiconductor devices having any desired number of external conductors.

The ends of the conductors 5 facing the foil 1 are provided with holding elements 7, 8 for the foil. The holding elements shown in the drawing consist of beak-like portions 7 and 8. Of course, the holding elements may also be constructed differently. The foil 1 is clamped between the beak-like portions 7, 8, the end of the conductor tracks present at the foil edge and the portion 8 of the beaks contacting each other. Said portions 8 can be connected in an electrically conducting manner to the conductor tracks 2 by means of a soldered joint.

Oppositely located holding elements are present at a distance which is smaller than the width of the foil 1, so that the foil can sag. In this manner the face of the semiconductor body 3 remote from the contact places 4 is able to engage a cooling plate 9 the outer surface of which is flush with an outer surface of an envelope 10 of a synthetic resin. The semiconductor body may be secured, for example, to the cooling plate by means of solder or adhesive, or may bear freely under pressure against the cooling plate. After enveloping, the supporting strip 6 is removed from the conductors 5 and the conductors are bent, if desired, so that they can be mounted in apertures of a printed circuit mounting panel.

Fig. 2 shows a second embodiment in which corresponding parts are referred to by the same reference numerals as in Fig. 1.

The conductors 5 the holding elements 7, 8 of which support the foil are present between the upright walls 11, 12 of a housing which consists of two parts. A semiconductor body 3 is again present on the foil 1, the contact places 4 being secured to the conductor tracks 2. In the bottom 13 of the lower part of the housing a cooling plate 14 is incorporated. The housing may preferably consist of a thermoplastic material, the cooling plate 14 being moulded in the bottom 13 of the lower housing. The cooling plate 14 can also be incorporated in the bottom 13 in a different manner, for example, by means of a snap fastener. The upper housing comprises a projection 15. Upon assembling the two parts of the

housing, the projection 15 presses the side of the semiconductor body 3 remote from the contact places 4 against the cooling plate 14, the cover 16 of the upper housing serving as a spring and ensuring a permanent pressure. The semiconductor body 3 may also be glued to the cooling plate 14, for example, by means of a heat-conducting adhesive, under pressure exerted by the projection 15. The envelope is completed by welding the upright walls 11, 12 of the upper and lower housing together, which also secures the conductors 5 in the housing. If desired, the space within the envelope may be filled, for example with a synthetic resin.

The semiconductor devices described have a number of advantages over other semiconductor devices in which a foil is used. The manufacture of combs is considerably simpler than the manufacture of a lead frame. Furthermore, a part of a comb may be used which contains the desired number of external conductors. In the case of a conductor grid and a different number of external conductors, an adapted grid must be used. The combs can be placed at such a distance from each other that the foil sags sufficiently to make a heat-conducting contact with the cooling plate. Since a very favourable solution is found for the heat dissipation, the power of the semiconductor device can be large. The envelope may also be provided with external conductors projecting on its four sides. In that case four comb portions may be used. Instead of the combs, separate strip-like conductors may also be used. The assembly is then slightly more complicated, but the cost of separate conductors is lower than that of combs.

WHAT WE CLAIM IS:—

1. A semiconductor device comprising an insulating foil on which a pattern of conductor tracks is present, a semiconductor body having contact places which are connected to facing ends of the conductor tracks, external conductors which are connected to the other ends of the conductor tracks, and an envelope for the semiconductor body, the foil and a part of the conductors, the conductors consisting of flat strips which project from the envelope on oppositely-located envelope sides, each of the conductors comprising at its end facing the foil a holding element for the foil, the distance apart of holding elements of oppositely-located conductors being smaller than the foil width at that area, and the face of the semiconductor body remote from the contact places being in thermal contact with a cooling plate which is present adjacent a wall of the envelope.

2. A semiconductor device as claimed in Claim 1, in which the holding elements consist of beak-like parts provided in the ends of the strips.

3. A semiconductor device as claimed in Claim 1, or Claim 2, in which the face of the semiconductor body remote from the contact places is rigidly secured to the cooling plate.

4. A semiconductor device as claimed in any of the preceding Claims, in which the envelope consists of a synthetic resin, and the cooling plate has a flat exterior face which lies flush with an outer surface of the envelope.

5. A semiconductor device as claimed in Claim 1, or Claim 2, in which the envelope consists of a box-like housing, the cooling plate being incorporated in one wall of the housing, and the oppositely located wall comprising an inwardly-extending projection which presses the semiconductor body against the cooling plate.

6. A semiconductor device substantially as herein described with reference to Figure 1 of the accompanying drawings.

7. A semiconductor device substantially as herein described with reference to Figure 2 of the accompanying drawings.

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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

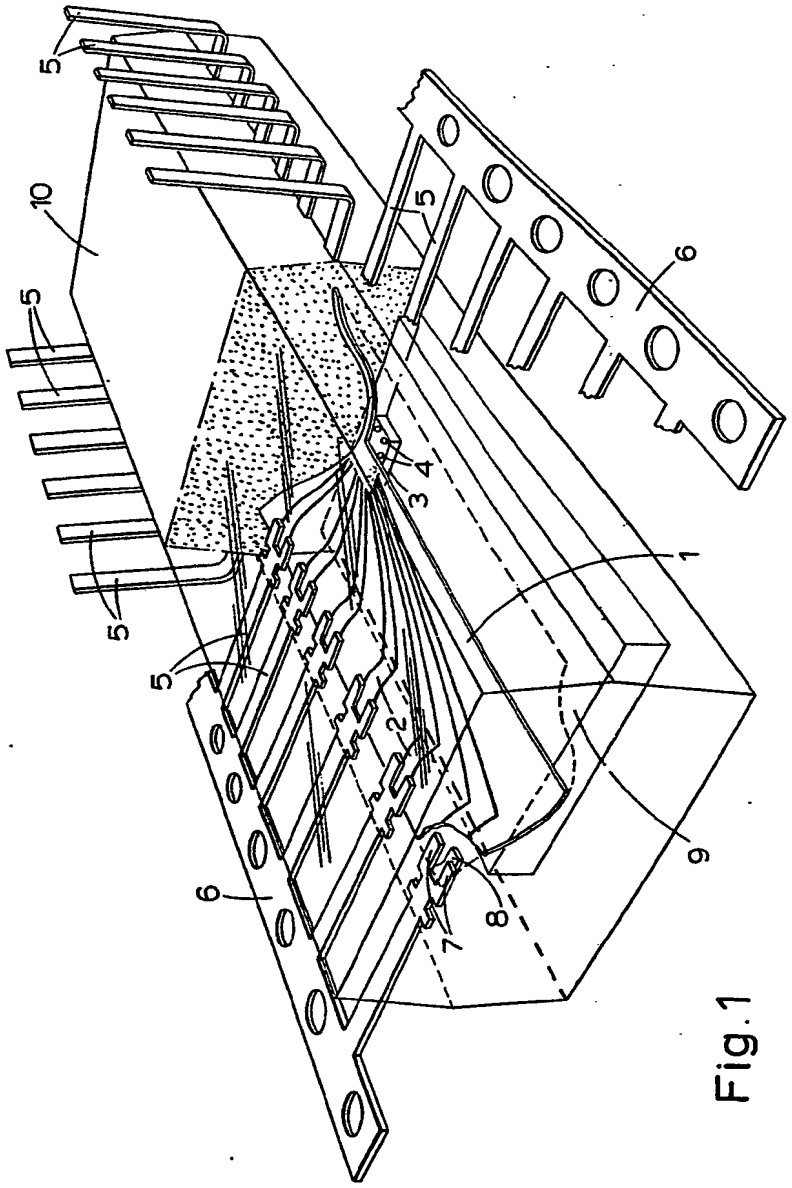

Fig.1

1403786 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

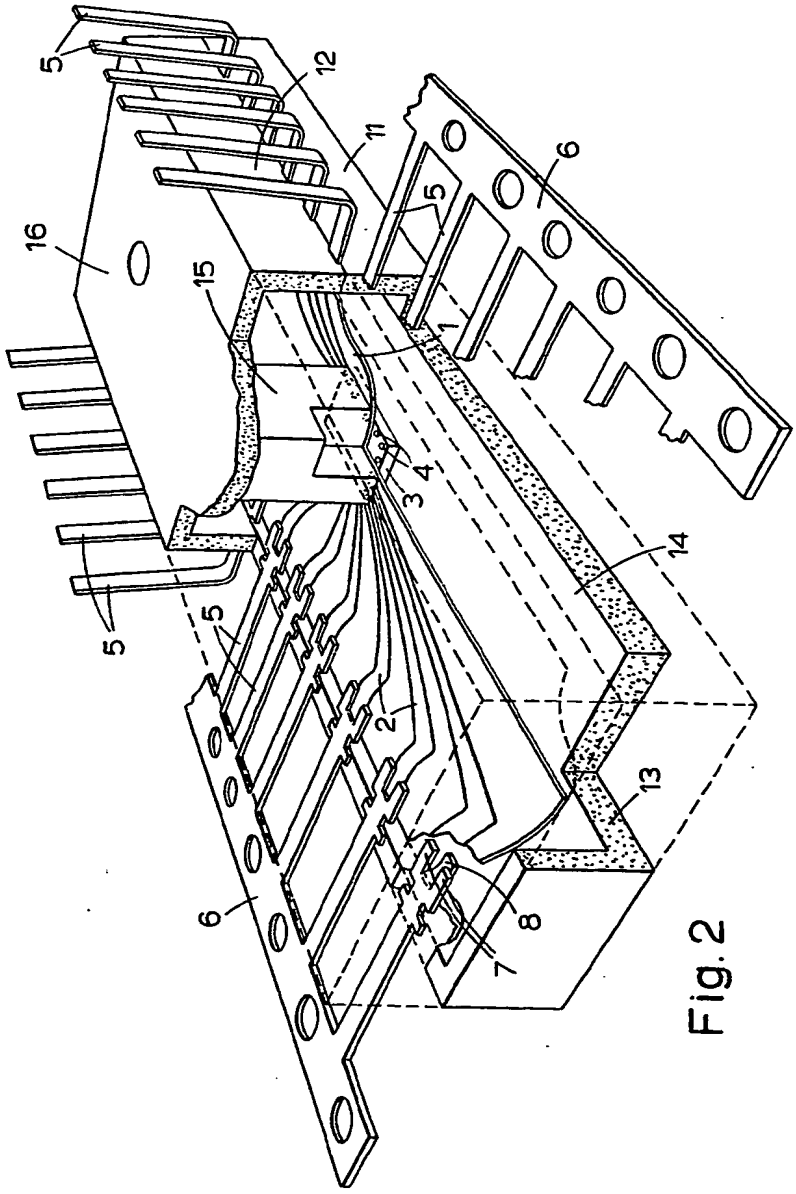

Fig.2